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OBSERVATIONS on the EFFECTS of GAS POISONING  
during the War, 1914-1918.

- by -

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HISTORICAL.

In the early days of the War, September 1914, the Germans, according to a French report used certain poisonous gases in shells. The evidence of this was not quite clear. Although certain cases of whole groups of men were reported killed, no abrasion or wound could be discovered, and it was assumed that they had been asphyxiated by poisonous gases from German shells.

The first definite attempt on the part of the Germans to use gas as an offensive weapon, was on 22nd April 1915. On that date between the hours of 4-5 o'clock in the afternoon, the Germans liberated gas from cylinders installed in their trenches situated on the North side of the YPRES salient. This sector was then held by the French, whose troops consisted chiefly of Territorials and Colonials. The wind was blowing from the North East and when the gas was liberated on about a seven mile front, it came over towards the French lines in dense white clouds.

The French troops in the front line were overcome with the fumes, and the majority of them were said to have/



have died from the effects of the gas. Those in the support trenches fled, terrified by this new horrible means of warfare. Several of these as they ran breathed the noxious fumes, which caused paroxysmal coughing, severe dyspnoea, copious frothy expectoration and vomiting. My own Battalion (9th Battalion (Highlanders) Royal Scots) happened to be out of the line resting behind the French at a small village called VLAMERTINGE. The first news we received of the attack was from a few French soldiers, who had beat a hasty retreat. These men gave a graphic and vivid description of this Hellish warfare. Soon afterwards we received orders to move, in order to support the French. However, as the gas attack had been so successful from a German point of view, we were unable to find any French to get in touch with. Thus a gap of about seven miles was caused in the line. The following afternoon, the 23rd at 4 p.m. we advanced against the Hun, who created several casualties in our ranks by machine guns and also by H.E. shells, with by what was then an unprecedented concentration of Artillery. That same day the Germans again used cloud gas against the Canadians, who held the apex of the salient. However, either owing to the wind not being so favourable, or the gas not being so concentrated, it had not the same drastic effect as on the previous/

previous day against the French. At the time this gas was liberated from the German trenches, we were about two miles distant. However, we noticed that our throats felt irritable and dry and our eyes smarted and watered. Two days later I got hit by a piece of H.E. shell and was sent to Hospital. I arrived at HAZEBROUCK some seven hours later, and here I found how extensive and horrible the damage by this gas had been.

I was admitted to a C.C.S. about 9 p.m. that night. The C.C.S. had beds for 220 but I believe that on that night there were over 900 patients. The corridors were filled with patients, a great many of whom were in agony, gasping for breath and having attacks of paroxysmal and violent coughing. At that time I was a combatant officer, but on telling the C.O. I was a medical man and informing him my wound did not prevent me walking about, he gave me his permission to allow me to help the other Medical Officers, and I was thus able to observe the early symptoms of Chlorine poisoning.

#### CHLORINE GAS.

Most of the severer cases exhibited deep cyanosis, pulse full, copious frothy expectoration, severe dyspnoea. There was extensive subcutaneous emphysema of the neck and also marked emphysematous signs in the lungs/



lungs.

One was not able to do much in the way of treatment except to relieve symptoms. Patients were kept in the fresh air as much as possible. Emetics, Respiratory stimulants and Morphia were given. Many of these patients died due, I think, to extensive <sup>2</sup>ordema of the lungs, but the majority improved on treatment. The following day my wound being very septic, I was evacuated to the Base, much to my regret, as I would have liked to have had further experience with those gassed cases.

#### METHODS EMPLOYED TO PREVENT GAS EFFECTS.

The Army at once took precautions against such an emergency again and every man was issued with a pad of gauze soaked in Hyposulphite of Soda, and this was tied over the mouth and nose by a piece of net. Previous to this one was recommended to urinate on ones handkerchief and tie it over the mouth and nose. Why urinate on it I could not understand and I don't think the Army ever tried the experiment.

In June a cloth helmet was issued. It consisted of a flannel helmet for the head which tucked in under the coat. Two mica eye pieces were inserted to see through. This was a most uncomfortable, suffocating garment to wear. In July I returned to my Battalion as Regimental Medical Officer and found that I also had/

had to look after the anti-gas appliances. The duties were to examine the men's Helmets and see they were in proper repair and no cracks or leaks at the eye pieces, also to spray these helmets once a fortnight with a solution of Hyposulphite of Soda. Trenches were also provided with Vermol Sprayers into which Hyposulphite Solution was put. After a gas attack the earth in the trenches was turned over and sprayed with the solution, which was supposed to get rid of the gas. Dug-outs were treated in the same way. Empty shell cases were hung in the trenches to act as gongs and these were sounded on the approach of gas and thus allowed helmets to be put on. Blankets were fixed up over doors of Dug-outs and sprayed with Hyposulphite solution and were in readiness to be let down on the approach of gas. Towards the end of 1915 a new helmet was introduced which had a mouth piece with a valve, allowing one to expel air from inside the helmet, but not breathe it in unless it came through the flannel; these helmets were also specially treated and did not require the fortnightly spray, and glass eye pieces substituted for the mica ones.

The valve outlet for expiratory air was a great benefit and reduced the suffocating feeling which one had in the previous one due to the Carbon monoxide given off from the lungs.

We then possessed this latter helmet when we next encountered/



encountered gas to any extent, which was during the SOMME offensive in July 1916.

#### LACHRYMATORY GAS.

This gas however was sent over by the Germans in shells. The Germans would plaster certain areas with these shells, usually at Cross roads, or, as they did with us, a certain valley in the SOMME district called HAPPY VALLEY or the VALLEY of DEATH. This was a gully about a quarter of a mile across, through which all troops had to pass to get to the HIGH WOOD area. The gas had rather a pleasant mustard and cress smell, and it was intensely irritating to the eyes and made them water profusely. One felt as if one had follicular conjunctivitis. Men complained that it seemed as if their eyes were filled with dirt. The conjunctiva was inflamed, congested, <sup>and</sup> very painful, and one was unable to keep the eyes open. The throat became dry and had a burning sensation, which caused one to cough. It also in many cases produced nausea, vomiting, and pain over the stomach.

The above symptoms when seen on the spot seemed quite sufficient to put a man out of action. However, one soon found that if one got out of the locality where the shells were falling one soon recovered, and after this I never evacuated a man suffering from lachrymatory gas shell symptoms, and never saw any serious/

serious result develop from it, the eyes recovering within an hour or two. The gas the Germans used in those shells was "BENZYL".

Before further discussing the various gases in detail it would be well to consider the different gases used by the Germans, their Chemical composition and their effects on the various organs and tissues of the Body.

Most important of all -

#### Lung Irritants.

Chlorine  $\text{Cl}_2$ .

Phosgene  $\text{Co.Cl}_2$ .

Chlor.methyl chloroformate  $\text{C.H.}_2\text{Cl.C.O.O.C.L.}$

Tri.Chlor.Methyl chloroformate  $\text{C.C.L.}_3\text{C.O.O.C.L.}$

The actions of the above caused direct inflammatory condition of the respiratory passages and alveoli of the lungs, giving rise to acute pulmonary oedema and death by asphyxia.

#### Vesicants.

Di.chlor.ethyl. sulphide  $(\text{C.H.}_2\text{Cl.C.H.}_2)_2\text{S.}$

This gas also causes intense respiratory inflammation but its principal action is an acute blistering of the skin and an intense conjunctivitis so severe that the patient is blinded; photophobia, with excruciating pain.

#### Lachrymators.

Benzyl Bromide  $\text{C}_6\text{H}_5\text{C.H.}_2\text{Br.}$

Xylol/



Xylyl Bromide  $C_6H_4$   $C.H._3$   $C.H._2$  Br.

Bromo Acetone  $C.H._2$  Br.C.O.C.H.<sub>3</sub>

These also in strong concentrations may act as lung irritants but personally I have never noted such a case, but for a short period they cause intense irritation of the eyes, profuse lachrymation, severe pain and temporary blindness. Nasal Irritants.

Direct poisons of the nervous system and gases interfering with the composition of the Blood were also used, but I had no personal experience with those, and thus no observations or notes, excepting the last named (namely those affecting the composition of the blood). My experience in this gas was had while I was Regimental Medical Officer to the 9th Royal Scots, but it was not due to the action of the enemy but arose from the fumes given off from coke braziers.

#### PHOSGENE GAS.

The next gas we encountered was much more serious and in fact was the most dangerous gas the war produced, namely, Phosgene. This gas had been previously mixed with Chlorine in the cloud gas attacks, but had not met with much success owing to the fact that it soon got diluted by the air. In July 1916, the Germans commenced throwing over shells containing Phosgene gas. These shells caused a peculiar noise when passing through the air and sounded as if they were turning over and over (a similar noise to that which/

which a nose-cap of a shell produces when it leaves the shell). The shell when it landed sounded as if it were a "dud" (as if it did not explode).

The Regimental Medical Officer of the Battalion we relieved in the High Wood sector about July 20th informed me that he had many men who reported sick complaining of feeling done and breathless, but that he could find nothing wrong with them, and would send them back to duty. However, a few hours afterwards he would be called to see some of those men. They would then be suffering from severe Dyspnoea and a quick running pulse.

While we were in this sector the Battalion had many of these shells thrown over in their vicinity and I had a similar experience, and treated those cases with great care, and as far as possible evacuated them on stretchers.

Several of the men had felt this feeling of tiredness and shortness of breath and did not come sick with it, but eventually found they were unable to walk and when I saw them they were suffering from severe Dyspnoea with a running pulse. During one of those bombardments a dug-out was penetrated with one of those shells, and when the five men were extracted, four of them were dead, their faces being very cyanosed and an extensive foam round their mouth and nose/



nose similar to that of a drowned man. The fifth man died shortly after extraction suffering from severe dyspnoea. He was the only one of them who had been hit. Had a fractured thigh and a wound in the shoulders and had lost a good deal of Blood, which as I learnt later was good treatment for a Phosgene case and probably accounted for his living longer than the rest. Two of the party who extracted the men were overcome with the gas; they had severe vomiting and a rapid running pulse and were also evacuated. However, the majority of cases I had at this time were only slight, feeling done up, breathless on the slightest exertion and the characteristic fast running pulse. In a great number of those cases it was uncertain how long it took for the effects of the gas to come on, as most of the men had no recollection of anything unusual as Phosgene is almost odourless. Some, however, had the early symptom of vomiting. There was no doubt that in some cases there was delay in the appearance of the symptoms. One of the officers developed symptoms thirty eight hours after we had been out of the line. He had the usual running pulse, felt absolutely done up, vomited and suffered from Dyspnoea. On examining his chest, I found dullness at the basis and numerous fine creps all over the lungs.

The/

The serious danger of Phosgene gas was still greater when it was found that the improved pattern of the anti-gas helmet did not keep out the gas. However, at this time the British Army was rapidly being equipped with the Box Respirator which was proof against all gases.

Up to the end of 1916 my experience of gas was limited to the very front line areas where one was able to observe the early symptoms, but it was quite hopeless to attempt examining patient's chest, etc., with all the noise of Battle going on.

However in 1917 I was transferred to 19th Field Ambulance and with this unit I had before long an opportunity of studying the effects of Phosgene gas poisoning more carefully.

In July 1917 we moved up to the NEUPORT sector where a large offensive on our part was expected to take place. In this sector the Germans were using gas extensively and causing very large casualties, and when we arrived in the XV Corps, General Newlands, the D.D.M.S., asked us to take over the C.M.D.S. and have there a special gas centre. He also asked that I might take charge of the gassed people, as I had previously worked for him and he hoped that I would be able to classify the cases and separate out those who could be returned to duty from those necessitating evacuation/



evacuation, and also to give early treatment to those cases urgently requiring it. We were situated close to COXYDE and within  $3\frac{1}{2}$  miles of the firing line. Special cars conveyed patients from the A.D.S. to the gas centre.

The gases which the Germans were then using were Phosgene and Mustard gas shells.

With regard to the Phosgene there is no doubt that it is the severest of all lung irritants.

#### SYMPTOMS & PHYSICAL SIGNS of PHOSGENE GAS.

The symptoms and Physical signs of Phosgene gas were very varied, all depending on -

- (1) The atmosphere.
- (2) The locality in which it fell.
- (3) Most important of all the Concentration.

(1) July and August were wet months in 1917 and the north of Belgium near the coast is a wet country and a net-work of ditches. Moisture seemed to have a special attraction for the gas and it hung about in the damp undergrowth for days.

(2) If a shell fell within a confined space such as a trench, dug-out or gun emplacement, it was much more fatal than in the open when the air carried it on.

(3) If numerous gas shells were plastered in one locality naturally the gas was soon concentrated and thus much more dangerous.

In/

In the first place let us deal with

Low Concentrations of Phosgene Gas.

The earliest symptom of all which may come on at once is a feeling of Nausea followed by vomiting but this was not present in all cases. The gas gave rise to immediate sensory irritation to the Respiratory system, chest felt constricted, throat dry, cough, and felt as if choking. The eyes watered freely and smarted. A few minutes after exposure to gas if a man tried to walk he felt giddy and staggered like a drunk man. Most of these cases on admission to the gas centre showed no Physical signs, except that the pulse rate was increased 120 to 140 a minute, but the pulse was of good tension and in many fairly high. After complete rest for three or four days the majority of these cases had quite recovered although a few developed respiratory symptoms (some even proving fatal) while others continued with an increased pulse rate, Tachycardia, and eventually were discharged to a D.A.H. centre for graduated exercises.

A few men I found had suffered from the above symptoms but had stuck to their unit and tried to do the usual strenuous work for a few hours, with the result that they eventually collapsed and in all these cases I found the Tachycardia most persistent and also that they were liable to short attacks of Dyspnoea simulating/



simulating Asthma, which would last from 5 to 15 minutes. Thus proving that rest was one of the most important factors in the treatment in Phosgene cases.

I had repeated occurrences of small parties of men being gassed, and I found that those who were evacuated by stretcher recovered much earlier and showed less symptoms than those who were evacuated as walking cases.

#### With Stronger Concentrations.

Symptoms more acute and the sensory irritant more violent. Symptoms usually ushered in by vomiting, Headache pain behind the sternum and in the epigastrium. Patient breathes in gasps, with paroxysms of coughing, although cough is not a prominent symptom of Phosgene poisoning. Inspiration gave rise to severe pain, Chest felt constricted as if a tight band was round it. Respirations rapid and shallow.

Physical Signs. In the above symptoms one would expect to find abnormal Physical signs in the lungs, but the only thing to be made out was a diminution in the length of inspiration.

The majority of those cases did well under treatment if they were got in the early stages, and made a complete recovery although a few showed signs of Bronchitis which in a rare case or two went on to Broncho Pneumonia.

Exposed to very Strong Concentrations of Gas.

Onset very sudden and lungs soon became oedematous.

As the Oedema increases, asphyxia becomes more pronounced, owing to the fluid interfering with the exchange between the blood and the air in the lungs. Thus the want of oxygen is the predominating feature.

Many cases exhibit great restlessness and anxiety, others delirious or semiconscious, but were usually able to be roused to answer questions.

The amount of expectoration varied, in some it was copious, thin and watery, and occasionally contained streaks of Blood, while in others it was scanty. Foam like that of a drowning man was frequently found round the nostrils and mouth, but this was a very serious sign.

Many cases died on the way down in the ambulance and this foam was one of the characteristics in all those cases.

Those cases which showed marked and serious signs of Pulmonary Oedema, one was able to divide into two types -

(1) The deeply cyanosed.

(2) The pale livid type.

which always used to bring to my mind the two different asphyxias found in the new born child, namely, Asphyxia Livida and Asphyxia Pallida.

The/



The deeply cyanosed cases were much more favourable to treat than the livid, and Blood withdrawn and N. Saline injected used to relieve them at once, but not so the livid type.

The Cyanosed group would have copious frothy sputum whereas in the other type sputum would be very scanty. The pulse in both cases was rapid and of good tension in the Cyanosed, but poor in the livid type. Temperature raised varying from  $101^{\circ}$  -  $104^{\circ}$ . In many cases the gas symptoms were complicated with wounds, and in a few of these cases I really think they benefited by the wound, probably due to the loss of Blood which relieved the right side of the heart and eliminated some of the toxins from the blood. This, of course, depended on the severity of the wound, and in such a case as Pte. C. No. 41598, who was admitted with a G.S. to L. Thigh Compound fracture plus Phosgene gas poisoning. His respiratory distress was so severe that he was very restless, he was vomiting yellow fluid along with copious frothy mucous.

Owing to his continued retching and turning about his leg was never still and thus he also suffered from severe Shock. Anaesthesia was quite out of the question owing to his respiratory condition. Hypo of Atropine  $\frac{1}{100}$  gr. to stop secretion, Calcium Chloride to stop vomiting, and oxygen, were given without avail and/

and he died a few hours after.

A typical case of Phosgene gas not complicated with wounds was Pte. F., R.I. Fusiliers. Admitted 11th August 1917, 7 a.m.

- (1) Sputum; Copious yellow frothy mucous sputum.
- (2) Froth round nose and mouth like drowning man.
- (3) Cyanosis marked (livid).
- (4) Rapid feeble pulse of poor volume.
- (5) Great respiratory distress.
- (6) Very Restless.
- (7) Vomiting.
- (8) Lungs showed extensive Bronchitis and Oedema.

Routine Treatment given which relieved patients respiratory distress, but at 11 a.m. patient moribund, pulse disappeared from wrist. Heart rapid and feeble like the ticking of a clock.

T. 104, R. 42.

Remained in same condition over 12th except pulse again appeared, rate 150.

On 13th condition much improved. T.103, R.36, P.120.

On 14th still progressing. Cyanosis similar to Mitral Heart lesion, lungs clearing, conscious and hungry.

On 17th eating well, good colour. T.98.4, R.22, P.90.

No signs of Oedema in the lungs, few scattered Ronchi, evacuated/



evacuated to C.C.S. for ambulance train.

### POST-MORTEM APPEARANCES.

This was one of the few cases I had time to make a Post Mortem on, and the chief points I found were as follows :- Trachea congested. Pleural cavities contained a good deal of serum exudate. Lungs markedly congested and oedematus. On section lungs showed abundance of frothy serum exudate. The lungs seemed very heavy but they floated in water. Veins were engorged. No change visible in Heart, Liver, Spleen, Kidneys or Intestines.

Another P.M. on a similar case much the same condition was found.

Both those two cases were of the Cyanosed type.

### Delayed appearance of symptoms of Phosgene.

Both in slight and severe concentrations of gas, no symptoms of acute poisoning may appear for many hours afterwards. During the interval the patient might vomit, which will relieve his headache, and he may think he is quite well again, when suddenly acute respiratory symptoms will develop, which very often come on soon after a heavy meal. A good example of this was a working party of the 2nd Royal Inniskilling Fusiliers.

They/

They were working in a front line trench on the morning of the 11-8-17 at 1 a.m. when the Germans suddenly opened a bombardment of gas shells. A few of the men got partially buried which caused delay in getting on their masks. They felt a faint smell like sulphur which caused a choking sensation. When they got clear of the trench, Box Respirators were put on. However, some of them had to take them off owing to vomiting or breathlessness. They left the shelled area and soon improved in the pure air. The party then set off to march to their Billets five miles behind the line. After they had gone about half way, four men fell out complaining of Breathlessness and feeling done up. During the last mile three of the party became very giddy and had to be supported by their comrades and were just like drunk men.

When they arrived at their Billets at 5 a.m. ten reported sick and were sent to C.M.D.S. Amongst those were the three who had difficulty with the last part of the march. The remaining twelve had a good meal, and then lay down in their Billets, but woke up soon afterwards gasping for breath and were admitted to the C.M.D.S. about 8 a.m. All of them suffered from severe Dyspnoea, headache pain behind the sternum etc., and were of the cyanotic type. Temperatures varied from 99°F. - 102°F. Pulses over 100 and of good/



good tension. They all received immediate treatment and greatly improved with the exception of two who died.

(1) No. 43887, died three quarters of an hour after admission, treatment being of no avail.

(2) No. 4644, Pte. P., improved under treatment. Respiratory distress relieved. Chest showed impaired note at the bases, and fine crepitations all over the lungs. The following day Broncho Pneumonia developed and he died on the 13th.

#### PROGNOSIS.

I soon learnt that this should be very guarded until a patient had been under observation for three to four days, but if no symptoms developed during that time, the patient was very unlikely to suffer from the effects of the Poison.

The Tachycardia in some cases was persistent and a few cases, which were sent to the Corps Rest Station, had eventually to be evacuated to Base Hospitals. The slight cases of Bronchitis following the gas poisoning invariably cleared up and had no recurrence. But then with severer lung symptoms I found some were liable to attacks of Nocturnal Dyspnoea simulating Asthma, and I learnt from a Base Hospital that had considerable experience in these cases, that in all the Haemoglobin percentage was increased always being over 100%. Accompanying this was an increase in the/

the number of the Red Blood corpuscles in the Blood. The case of an ex-gunner of the R.A.F. who was a patient in Ward 28, Royal Infirmary, Edinburgh, during June 1919, suffering from Bronchial Asthma from the effects of gas poisoning in 1917, showed there Phenomina along with quite a definite Eosinophilia.

Acute gas poisoning by Phosgene like Influenza is liable to bring on Tuberculosis of the lungs and I have seen several cases that have developed Phthisis and in five of them there was no previous family history of Tuberculosis.

#### Treatment.

After three days work at the Corps Main Dressing Station at COXYDE, we divided the gassed cases into three Sections -

- (1) For the severe cases.
- (2) For the Medium cases.
- (3) For the Light cases.

All patients were brought into a large receiving room where their particulars were taken and then sorted into the above three classifications.

The severer cases including all those with great respiratory distress were at once taken to the theatre and the Medium Basilic vein exposed. A half to one pint/



pint of Blood was withdrawn and normal saline corresponding to half the amount of Blood withdrawn was injected intravenously and in many cases one C.C. of Pituitrin was included in the Saline. This treatment I found differed from that used by the C.C.S., which was situated further back. There they drew off Blood, but did not give an intravenous injection afterwards, their argument being that they were relieving the right side of the Heart and that my treatment was only partially doing so, as I injected Normal saline corresponding to half the amount of the Blood back again. However, I held that I was relieving the right side of the Heart to a certain extent, but that I also was diluting the toxine in the Blood by injecting the Normal saline.

I tried several cases with only drawing off the Blood but came to the conclusion that they did not get well so rapidly as the others.

After the patient was finished in the theatre, he was taken to a large hut, undressed and put to bed. Round the Hut there was a continuous pipe to which was attached Oxygen cylinders. At each Bed the pipe gave off a branch, thus allowing if necessary 26 patients to receive Oxygen at once.

The Oxygen was administered to the patients either by means of a glass funnel fixed in the vicinity of the patients mouth or a small rubber tube passed up a nostril. It was administered for five minutes/

minutes at a time with intervals of ten minutes, as I found that continuous administration was apt to make the patients more restless except in a few cases.

There is no doubt but that Oxygen was very effective treatment for these cases; Under its administration Cyanosis would gradually disappear, and the pulse rate would be slowed by 20 or 30 beats. The patient would also be greatly quietened and that feeling of restlessness and impending fear of some catastrophe would pass off.

In those cases in which Oxygen increased the restlessness and did not give relief the prognosis would be very grave, thus showing that the toxine or the excess of  $\text{Co}_2$  formed in the lungs had poisoned the respiratory centre beyond repair.

Patients should be kept warm. Cardiac stimulants such as Digitalin  $\frac{1}{100}$  Strychnine  $\frac{1}{40}$  Hypo. Brandy, Pituitrin l.c.c. were given.

Expectorants. I used very little except in the milder cases when I gave Ammonia Carbonate and Vinum Ipecacuanha along with Potassium Iodide.

Vomiting: if severe, an emetic would be given such as salt and water to try and eliminate the toxine, but if persistent vomiting, it was always relieved by large doses of Calcium Chloride.

These/



These cases were detained at the Corps Dressing Station until their lungs cleared and Temperature and pulse came down, but this was usually rapidly accomplished, most cases being well enough to move in three days, but were evacuated as Stretcher Cases.

#### The Medium Cases

were sent to the Wards at once and put to bed, and treated for lung or Heart condition and like the previous cases kept in bed, but most of them were evacuated to C.C.S. owing to lack of accommodation.

#### The Slight Cases

were given a change of clothing and advised to rest as much as possible. They were kept under observation for four days, and if no Physical signs had developed were then either sent to Duty or to Corps Rest Station for a week. However, among them one occasionally found cases of delayed gas poisoning.

The two important and most urgent necessities in Phosgene poisoning are rest and fresh air. If possible the patient should be a Stretcher Case from the first. Tight clothing should be removed.

The Diet of the severe cases as in Pneumonia, but the slight ones can take ordinary diet although it should be restricted for the first day.

MUSTARD/

MUSTARD GAS.Di - chlor - Ethyl - Sulphide.Historical.

A severe irritant to the lungs, mucous membranes, and skin. This gas was first of all used by the Germans at YPRES in June 1917 when we commenced that very costly attack which after fighting for six months, and suffering tremendous casualties we won the PASCHENDALE RIDGE. The 15th Division (Scottish Division) were the first troops to come in contact with the gas, and as they were mostly kilted regiments they suffered severe casualties.

The Germans did not use this gas extensively again until July in the NEUPORT sector, where we were then stationed, but then they used it very extensively and seemed to have an endless supply.

Mustard gas has only a very faint odour; it smells like Mustard from which it gets its name.

Unlike Phosgene it does not produce immediate irritant effects. After a few hours it produces severe inflammation of the Eyes, and also the Mucous membrane of the air passages and causes burns on the skin. The commonest of these was the irritation to the eyes, which rendered a man quite unfit for duty, and in many cases caused complete blindness, and the man had to be led about. However, as far as danger to/



to life was concerned the Respiratory irritation was much the most serious. The Burns of the skin in a few cases were so extensive that the patient died from shock. The Mustard gas shell contained a liquid (di-chlor-Ethyl-Sulphide) and where the shell burst the liquid sprayed the ground or anything within the vicinity. The liquid being insoluble in water would be a source of danger for several hours afterwards in that area, and being soluble in oils and fats if it were sprayed over human skin it gave rise to intense irritation and vesication. If a man sat down on the ground previously sprayed by the liquid he would be severely burnt, with the result that the gluteal region was frequently affected.

Men who had been in contact with the gas were a source of danger in dug-outs, as the liquid clung to their clothes. A marked example of this happened in the Advanced Dressing Station of my Division at NEUPORT. It was in a deep dug-out well protected with gas blankets. After having had a very heavy day of dealing with Mustard Gas cases, all the Medical Officers and men developed symptoms of Mustard Gas poisoning, namely conjunctivitis, loss of voice, and later several developed erythema and burns on the fingers.

Typical/

Typical symptoms of Poisoning.

After a lapse of three to four hours from contact with the gas, the eyes begin to smart and water; they soon become congested and produce a typical case of Acute Conjunctivitis. Sneezing and running from the nose accompanies this and is then followed by a feeling of nausea, retching and even vomiting. Throat symptoms develop about six hours after exposure to gas.

Throat feels dry and burning; Voice husky, going on in some cases to complete Aphonia. Dry cough. About twelve hours after exposure, inflammation of the skin shows itself, which is most marked on those parts which are not covered with clothing, such as the face, neck and hands. It is also common where two skin surfaces are in contact such as the axillas, groins and buttocks. To begin with it looks like severe sun-burn, which may go on to vesication and produce characteristic burns, and if these vesicles are opened a thick yellow jelly is found. When it reaches the vesication stage the patients suffer great agony. In kilted soldiers the scrotum and penis were often affected and would be increased to three times their size and be intensely painful. However, in most cases, the erythema in two to three days would develop into an almost black colour (as if it had been touched/



touched with silver nitrate). This was quite painless and eventually the skin would peel and leave the normal skin below.

While this dark staining of the skin is present one would mistake a man for a nigger.

After 24 hours, the eyes are very painful, severe conjunctivitis and Photophobia, profuse watery discharge; the conjunctivitis in a few cases may give rise to a muco, purulent discharge. The eyelids become intensely oedematous and in some cases resemble the puffy eye of Nephritis.

The nose is continually running and very often a harsh cough. The third day may produce Respiratory symptoms but I have never seen them occur earlier and more frequently come on during the fourth day. The lungs then show signs of Bronchitis. Temperature, Respirations and Pulse rate rise and the condition may pass into Broncho-Pneumonia with a fatal result, but these cases were uncommon. By the above symptoms one can observe that Mustard gas poisoning is very different to that of Phosgene, Phosgene being an acute condition and the lungs soon affected, while in Mustard the eyes, skin, and larynx are first affected and the lungs seldom give trouble until the third or fourth day. Then it is a Bronchitis which may go on to Broncho-Pneumonia, but in no case have I seen the extensive/

extensive oedema so characteristic as in the lung condition of Phosgene.

Mustard gas in a few cases, where the shell had landed in close proximity to the patient rapidly produced extensive burns. One case I will always remember was a gunner in the R.F.A. who complained of great pain on his back and down his right arm. He was only able to lie on his left side. His history was that a German shell landed in his gun pit and threw him down (as they were throwing over gas shells at the time he had his box respirator on). Soon afterwards he felt great pain in his back and went sick. He arrived at the Corps Main Dressing Station diagnosed Myalgia. When I looked at his back (4 hours after shell had landed beside him) he had large burns all over his back and down the right arm. I immediately set to work to dress these, but while I was doing this other blisters rose up and eventually the whole of his back was affected. The burns were so extensive that he died eighteen hours afterwards from shock.

### Prognosis

of Mustard gassed cases was much more favourable than Phosgene. the only dangerous ones being those who developed Broncho-Pneumonia and a few rare cases of extensive burns. The puffiness round the eyes made me suspect Kidney involvement but urinary examination/



examination never revealed Albumen but in two cases I found sugar in the urine. The conjunctivitis and Laryngitis usually cleared up quickly within a month but in a few cases was troublesome for a long time but most of those cases probably had a neurasthenic element in them.

Burns did very well and I only saw one death from this cause.

### General Treatment.

All cases showing Mustard gas symptoms underwent the following treatment :-

1. Change of clothes. Severe cases put to bed in pyjamas and lighter cases fresh sets of clothing. The original clothes were hung out in the sun for two successive days which time was found sufficient to get rid of the gas on them. The orderlies who did this work wore gloves in order to protect their hands.
2. All cases were bathed down with a solution of Sodium Bicarbonate (5% Solution) or put in a specially constructed bath of waterproof sheets containing solution of Sodium Bicarbonate 5%.
3. Sodium Bicarbonate XXX grs. t.i.d. internally.
4. Eyes bathed with a 2% Sol. of Sod.Bicarb.
5. A Light cardboard shade to wear over the eyes to protect them from the sunlight which was extremely irritating to the eyes.
6. Inhalations of Benzoin  $3\overline{T}$  to a pint and  $3\overline{T}$  Sod. Bic.

I introduced the above routine treatment after I had had a week's experience of mustard gas. The majority/

majority of cases on admission only suffered from eye symptoms, and to begin with I treated these only. However I noticed that many of these cases developed a hoarse and husky voice on the second, third, or fourth day. On examination, the pharynx and larynx were inflamed and injected. Later the patient could only speak in whispers and complete Aphonia developed. In order to prevent this I had a small canvas cubicle erected in each Hut and a steam kettle was placed in each. Every man had ten minutes a day in these cubicles inhaling Benzoin and Sod. Bicarb. This treatment certainly did not prevent all cases of Tracheitis and Laryngitis occurring, but it greatly diminished the number. Menthol sprays were also used but not being so convenient for large numbers, the steam kettle was my routine treatment.

From one to six days after exposure, I noticed that this Erythema developed in many cases. To prevent this Sod. Bicarb. in large doses was given internally and either washed down or bathed in 5% Solution of Sod. Bicarb. This treatment gave splendid results and practically stopped the cases of Erythema.

The eyes gave much the most trouble as regards treatment. The symptoms here develop rapidly and in two or three hours a man would have such a severe conjunctivitis/



conjunctivitis that he would be a complete casualty. The seriousness of the case depended on the concentration of the gas. If that were slight and the resulting eye symptoms not severe, these cases cleared up quickly in three to four days, the eyes being bathed with Sodium Bicarbonate solution 2% and protected from the light by means of a shade. At one time I used to instill Castor Oil into the eyes, but stopped this treatment as I found it was inclined to make the eyes irritate more.

Severer cases were much more resistant to treatment. They were bathed as before with 2% Solution of Sodium Bicarbonate and a shade used to protect the eyes. When they became septic and there was a Muco purulent discharge, hot Boracic bathing was used. The pain was so severe in several cases that Morphia had to be used. All the severer cases of conjunctivitis were evacuated to C.C.S. and from there to a Base Hospital. The majority of these would completely recover within a month. However many cases persisted for a long time but this was due more to a Neurasthenic element than anything else, the patients keeping up the irritation by continually rubbing the eyes.

#### The cases with extensive Burns.

The Blisters were opened and in them was found a thick yellow gelatinous substance, quite different to the/

the clear yellowish fluid found normally in Burns of the Second Degree. This was removed along with the raised Epidermis and Ambrine was painted over the exposed congested and highly sensitive papillae of the skin. The Ambrine gave great relief and the burns healed rapidly.

Before Ambrine was obtained the Burns were treated with Picric Acid but this did not seem to relieve pain and Morphia had to be given, whereas the Ambrine relieved pain almost instantly.

The Erythema which did not go on to vesication required no special treatment. The surface was bathed with a 5% Solution of Sodium Bicarbonate and Sodium Bicarbonate given internally in large doses XX - XL grs. t.i.d. In some cases the skin would turn a coppery black colour which eventually would peel off and leave fresh white skin below. But the majority of the Erythema peeled in the same way as sunburn and closely resembles Scarlet Fever.

I much regret that all my charts of the cases I had under my care were destroyed owing to the enemy hitting and setting on fire the farm house we were billeted in, while they bombarded the Corps Main Dressing Station at COXYDE, the only thing I had left being/